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(54) **SESSION CONTROL FOR MEDIA STREAM TRANSMISSION**

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(63) Continuation of application No. 16/384,753, filed on Apr. 15, 2019, now Pat. No. 10,958,699, which is a (Continued)

(57) **ABSTRACT**

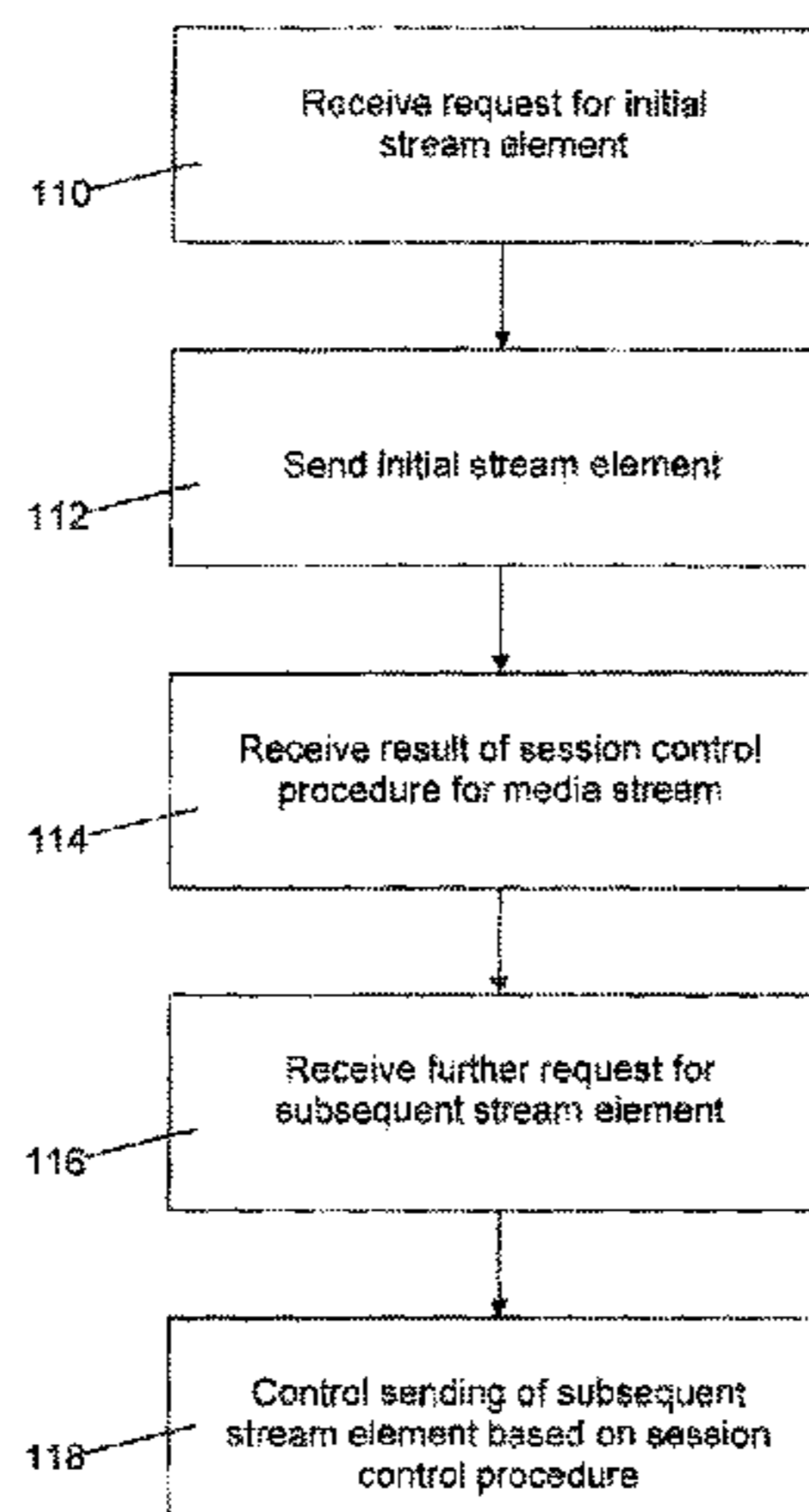
(51) **Int. Cl.**
G06F 15/16 (2006.01)
H04L 29/06 (2006.01)
H04L 29/08 (2006.01)

Systems and methods of controlling transmissions of a media stream are provided. In one exemplary embodiment, a method performed by a media client for controlling a transmission of a media stream from a media server to the media client may include obtaining a media description of the media stream. The media description may indicate an initial stream element of the consecutive stream elements. Further, the method may include sending a request for the initial stream element. In addition, the method may include requesting, towards a control entity for a session, an establishment of the session or a modification of the session, for associating the media stream with the session. After sending the request for the initial stream element, the method may include receiving a result of the session establishment or session modification request.

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CPC **H04L 65/4092** (2013.01); **H04L 29/06027** (2013.01); **H04L 29/06047** (2013.01); (Continued)

(58) **Field of Classification Search**
CPC H04L 65/4092; H04L 65/1006; H04L 65/1016; H04L 65/1046; H04L 65/105; (Continued)

20 Claims, 11 Drawing Sheets



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continuation of application No. 15/364,421, filed on Nov. 30, 2016, now Pat. No. 10,277,651, which is a continuation of application No. 13/811,334, filed as application No. PCT/EP2010/004879 on Aug. 10, 2010, now Pat. No. 9,531,579.

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 CPC *H04L 65/105* (2013.01); *H04L 65/1006* (2013.01); *H04L 65/1016* (2013.01); *H04L 65/1046* (2013.01); *H04L 65/1059* (2013.01); *H04L 65/1063* (2013.01); *H04L 65/1069* (2013.01); *H04L 65/4084* (2013.01); *H04L 65/80* (2013.01); *H04L 67/2823* (2013.01); *H04L 67/42* (2013.01)

- (58) **Field of Classification Search**
 CPC H04L 65/1059; H04L 65/1063; H04L 65/1069; H04L 65/4084; H04L 65/80; H04L 29/06027; H04L 29/06047; H04L 67/2823; H04L 67/42
 See application file for complete search history.

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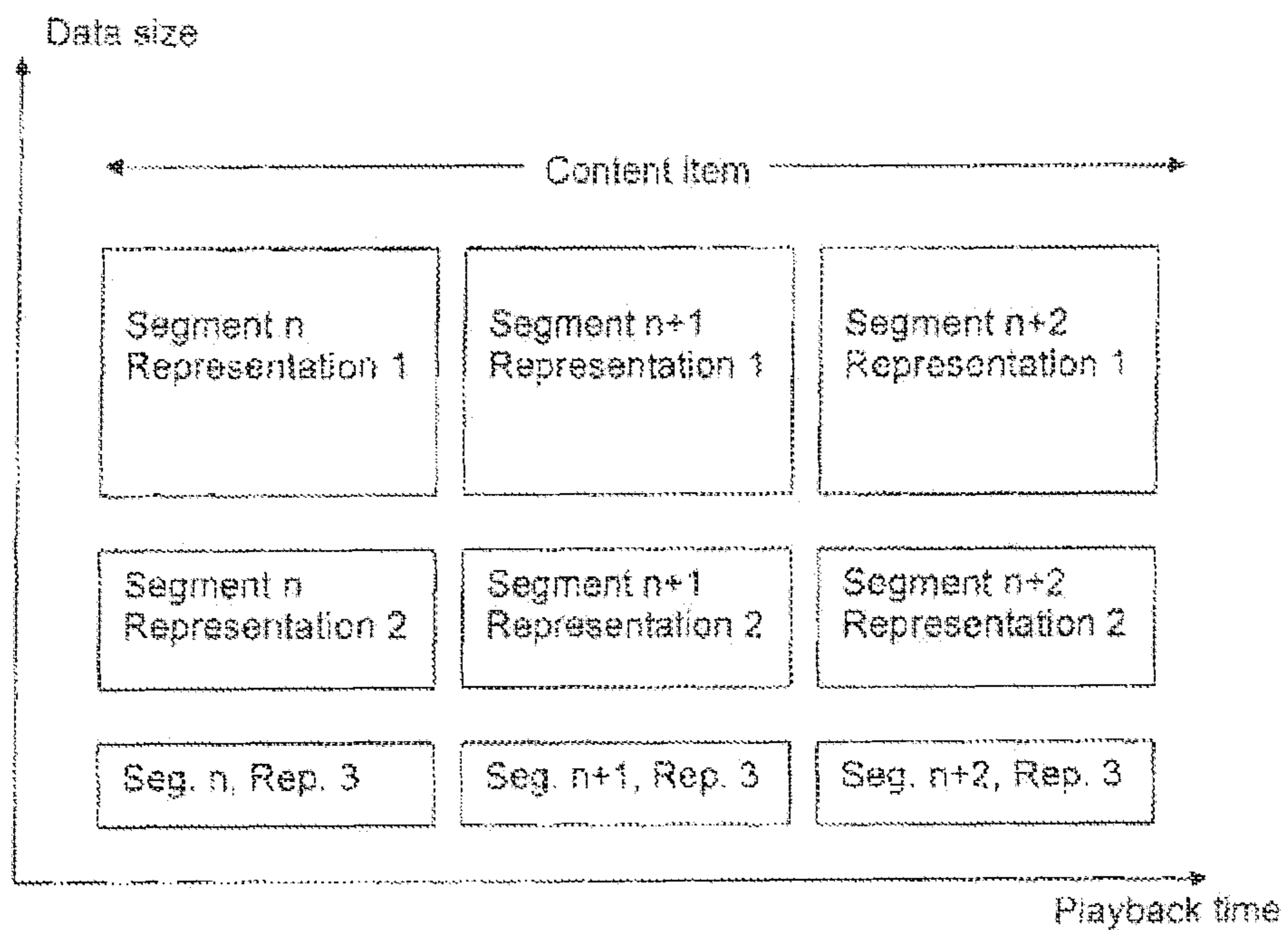


Fig. 1
(PRIOR ART)

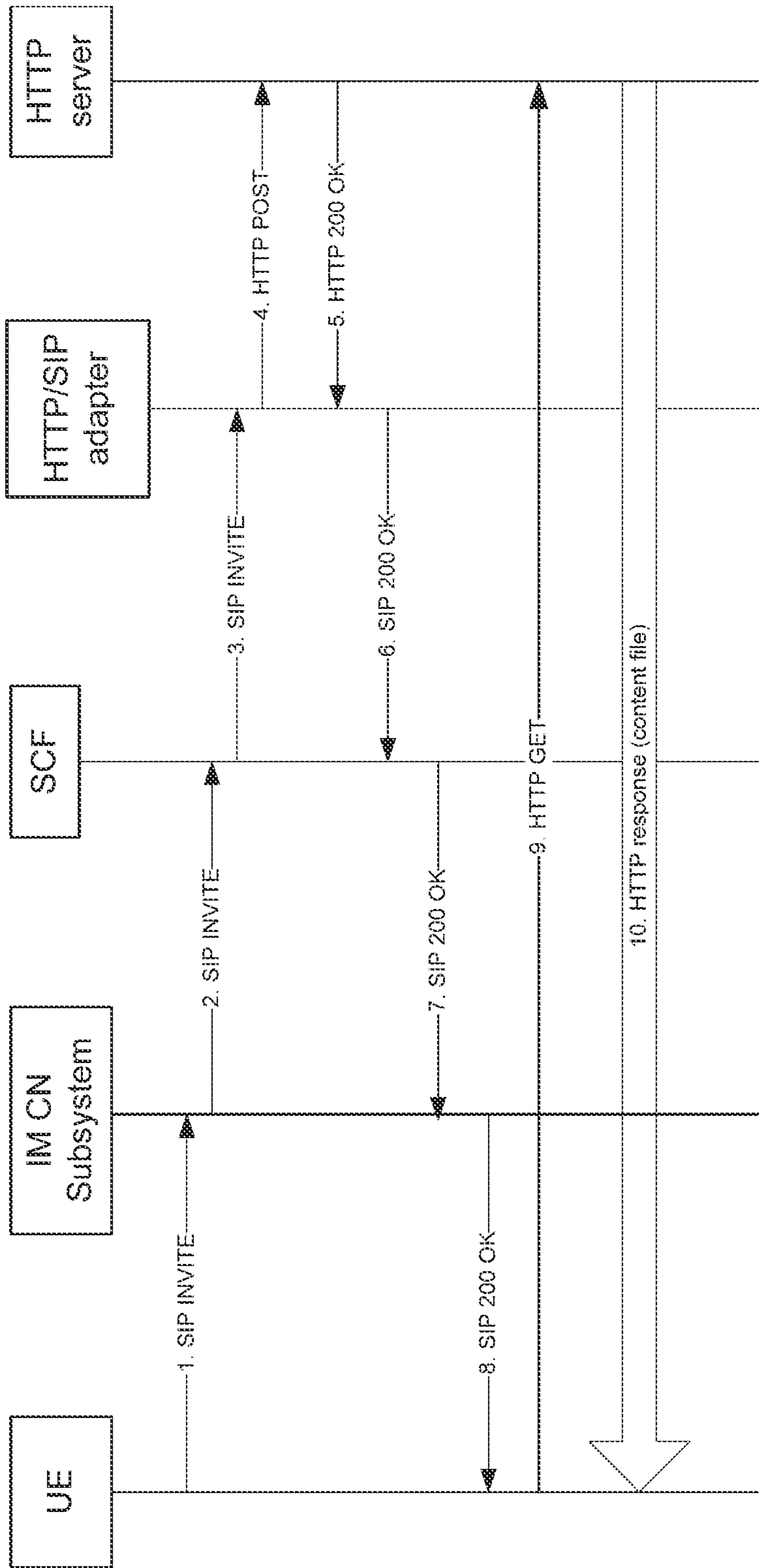


Fig. 2
(PRIOR ART)

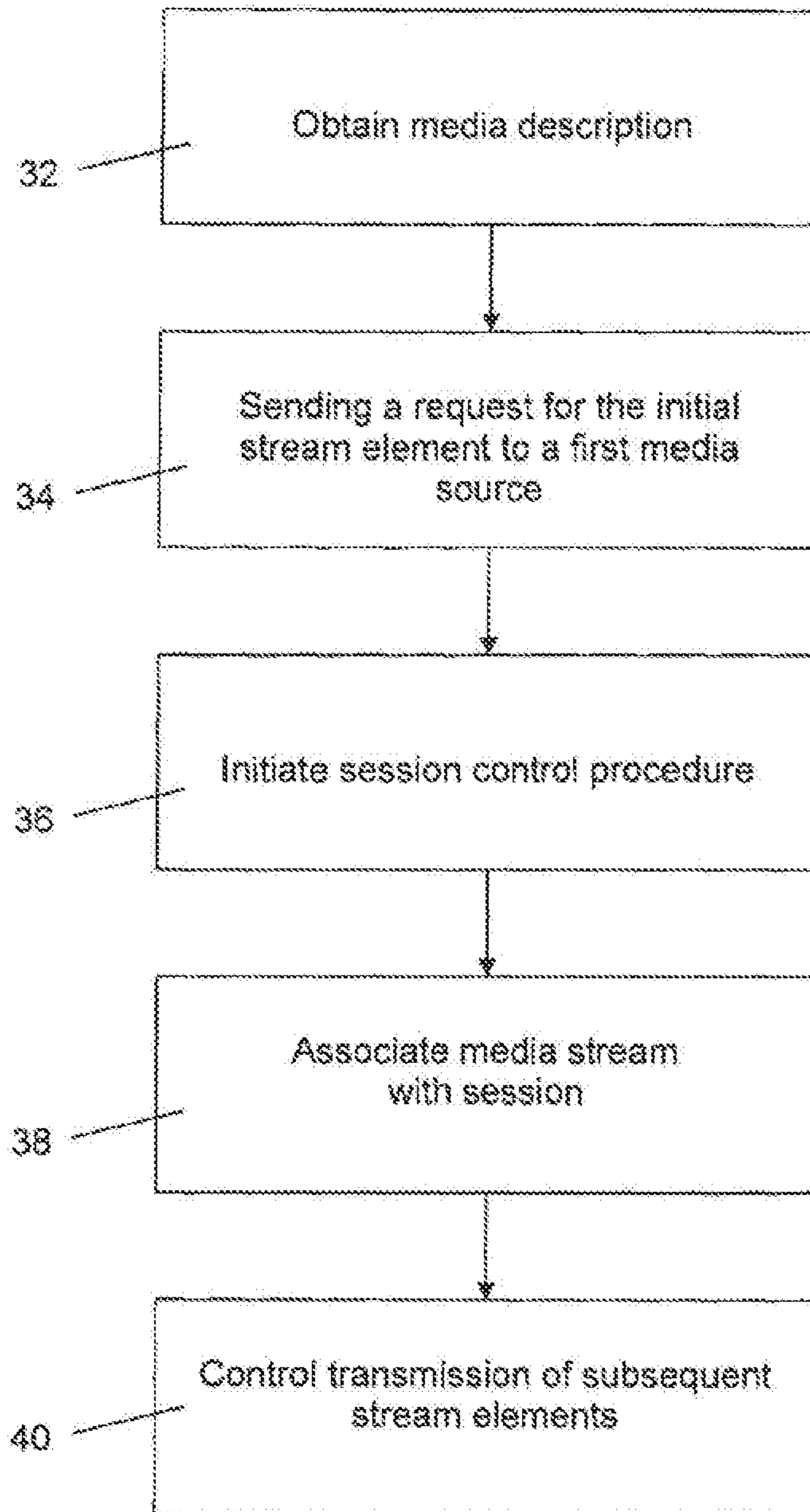


Fig. 3

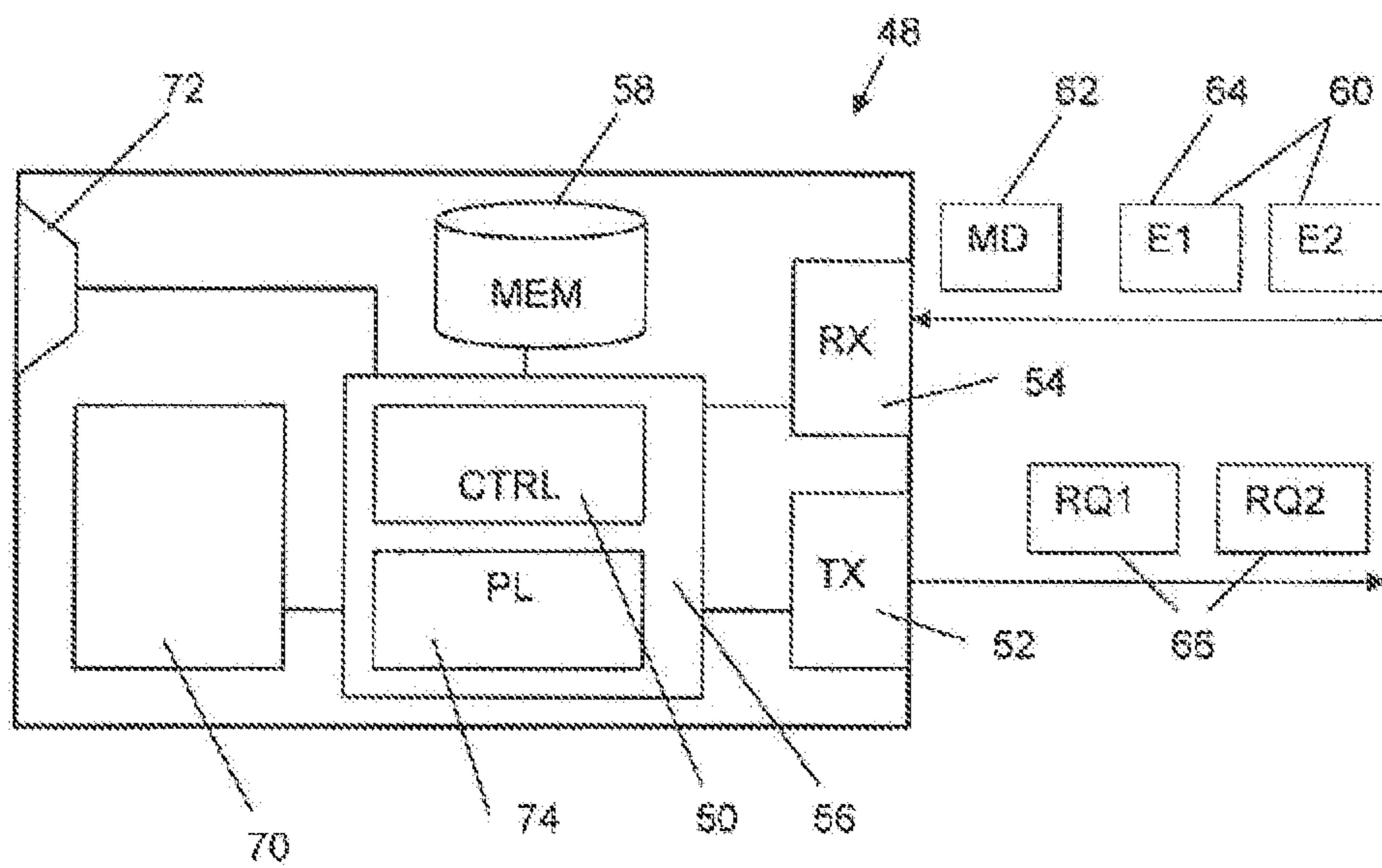


Fig. 4

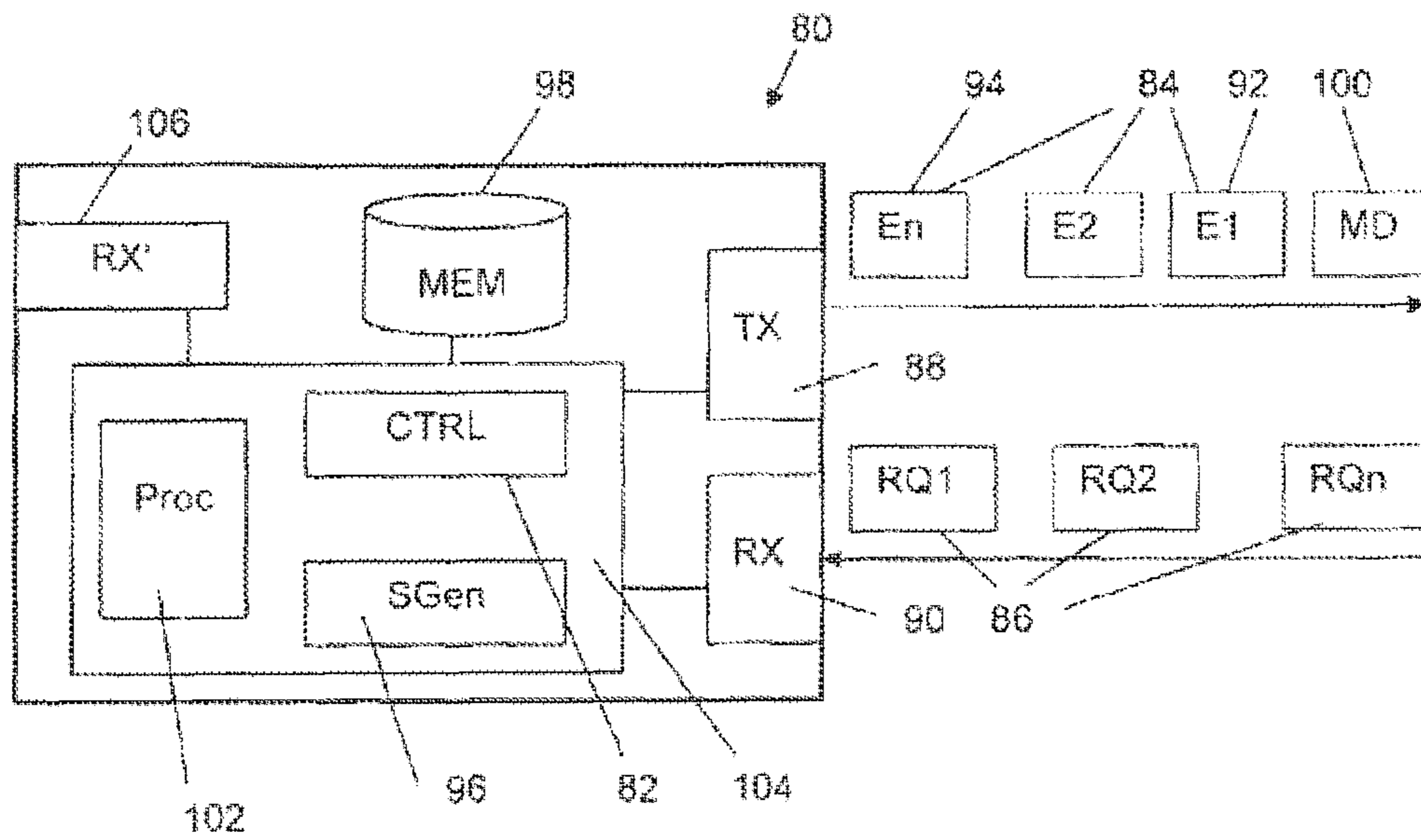


Fig. 5

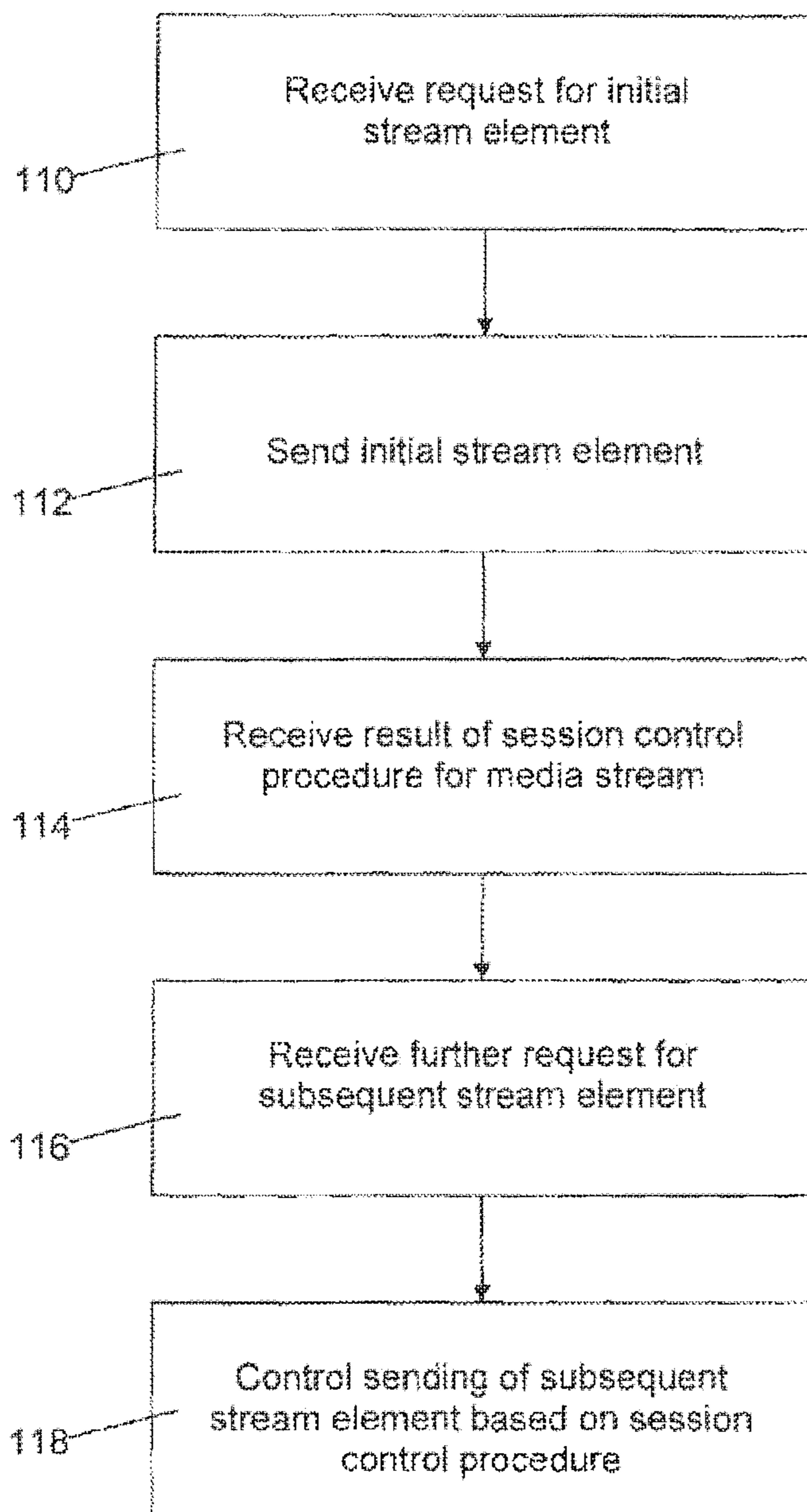


Fig. 5a

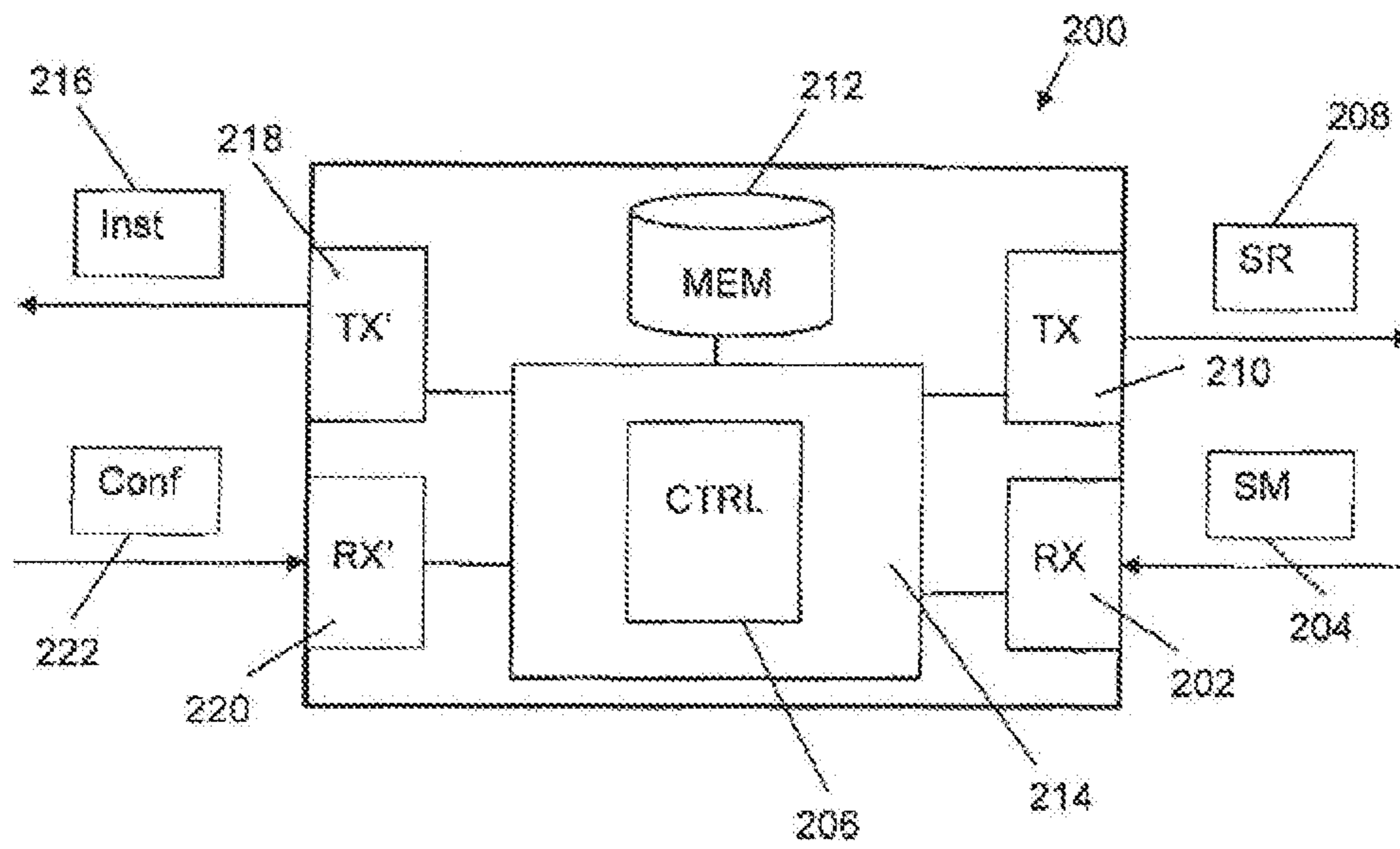


Fig. 6

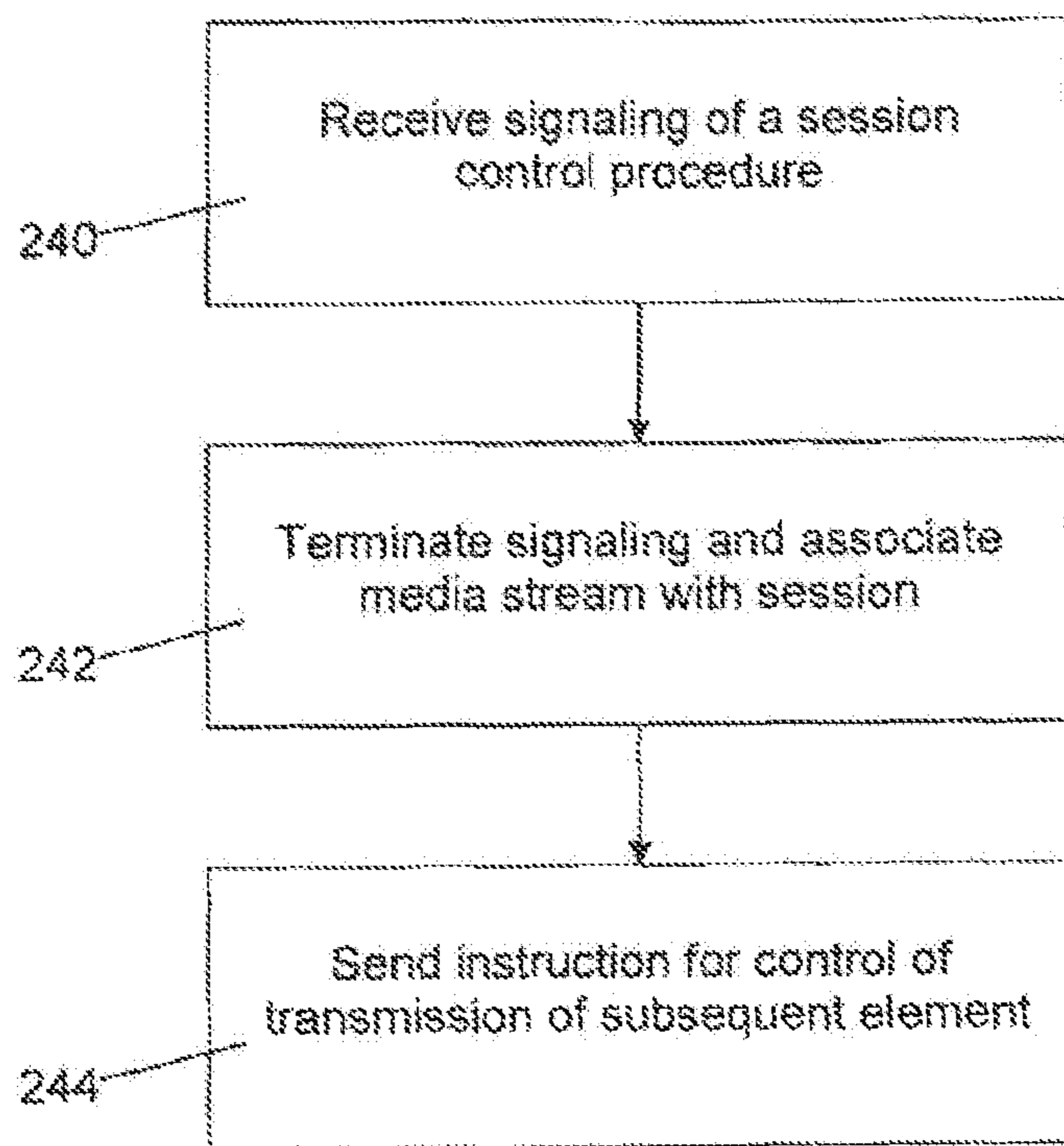


Fig. 6a

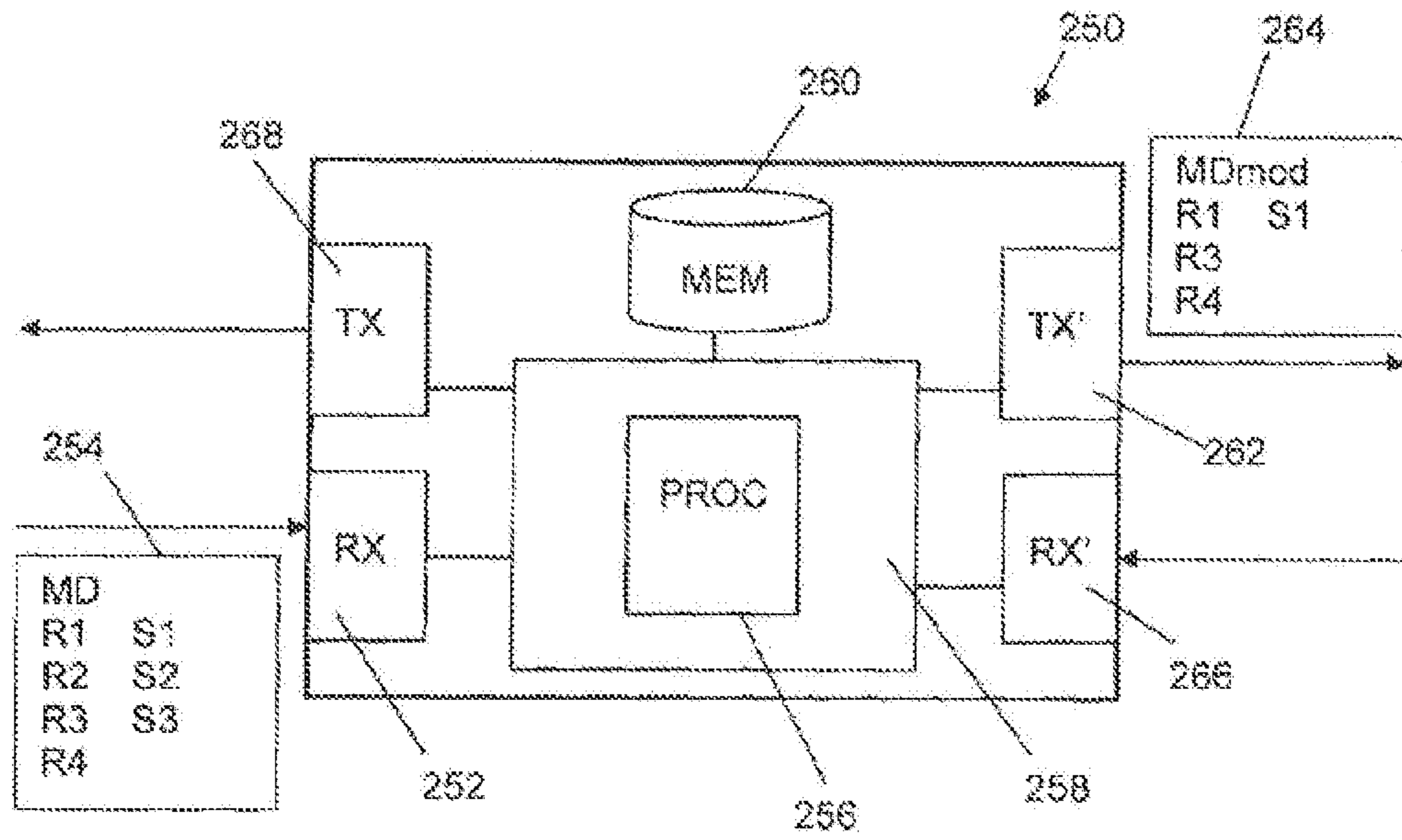


Fig. 7

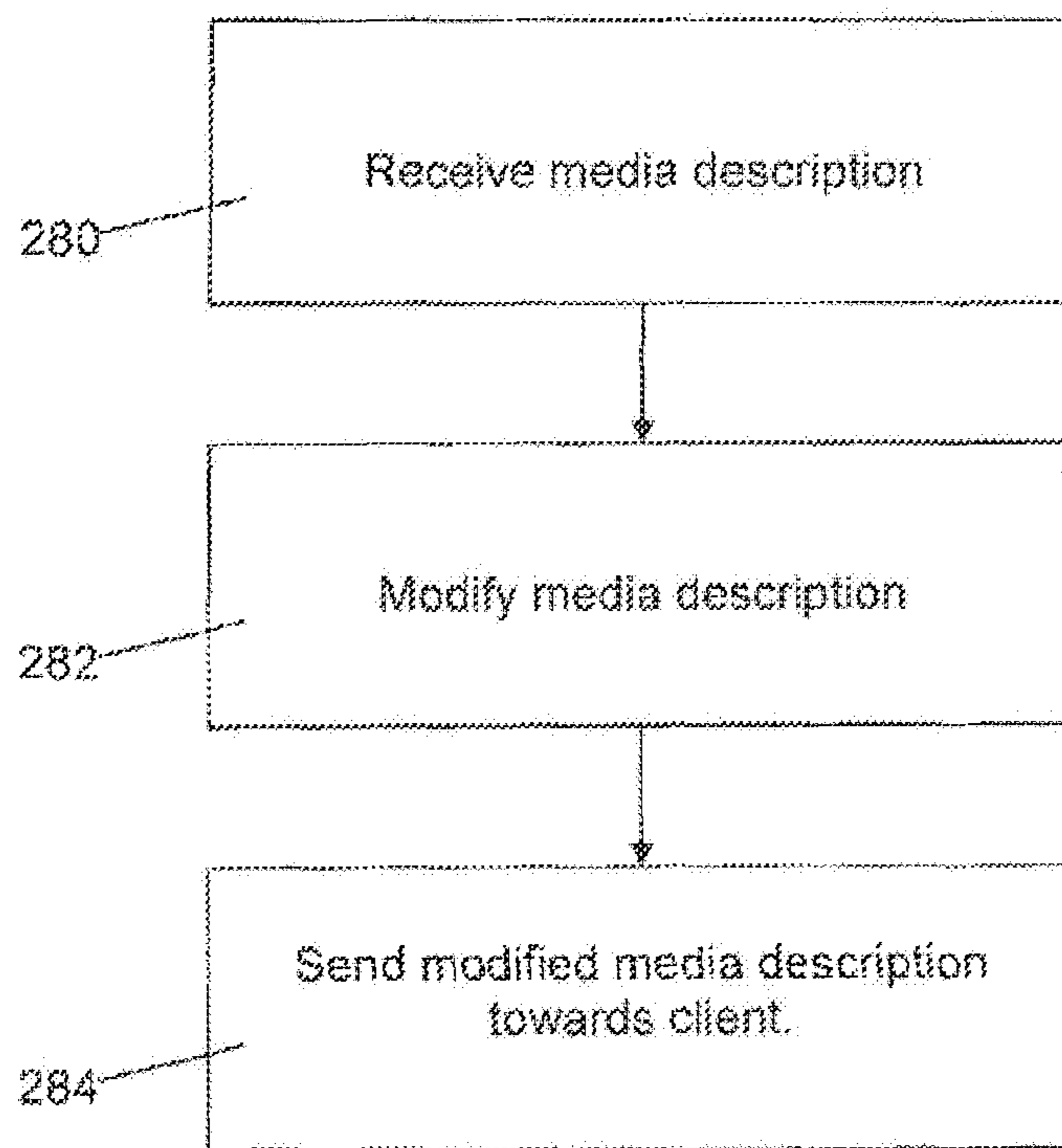


Fig. 7a

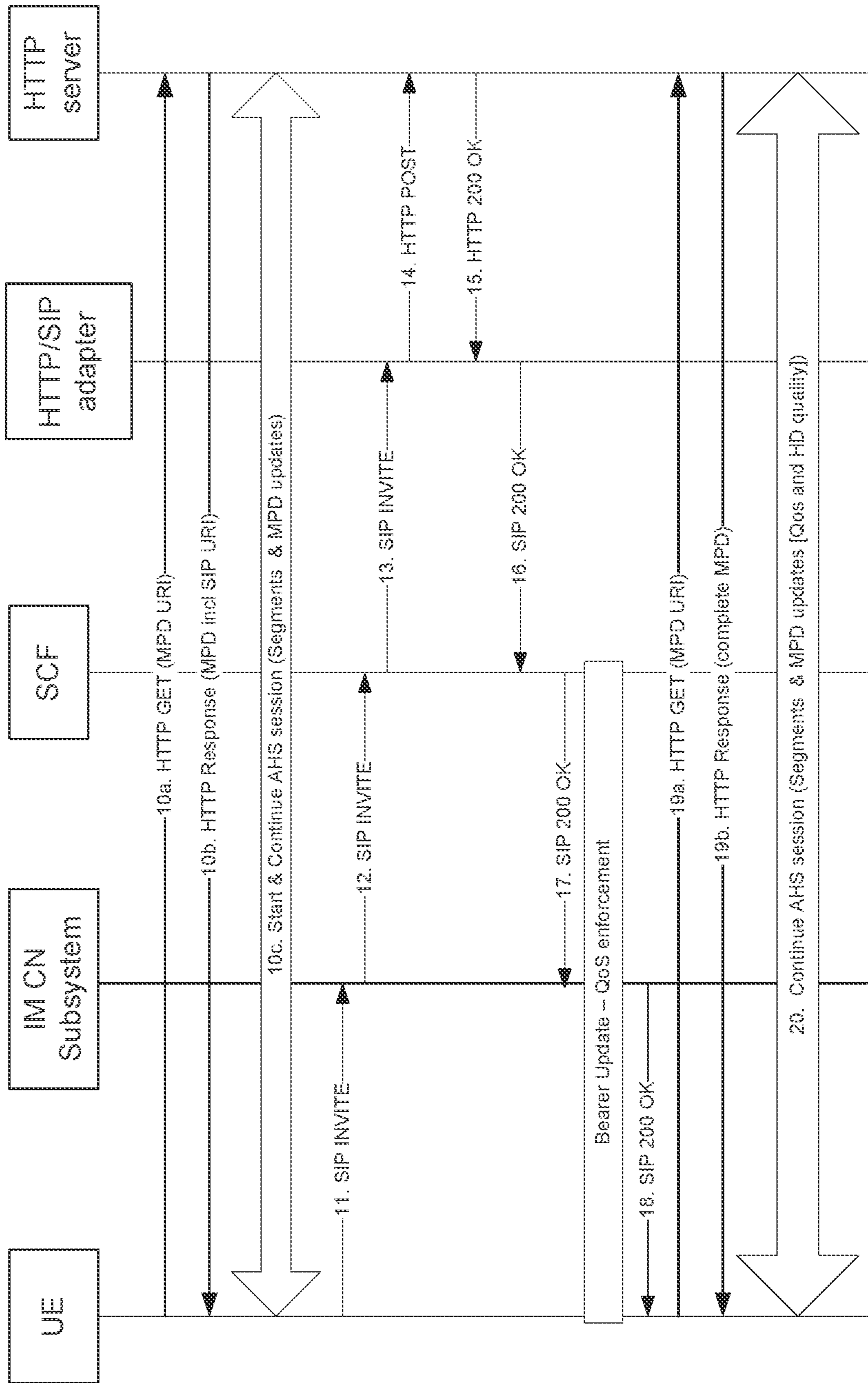


Fig. 8

SESSION CONTROL FOR MEDIA STREAM TRANSMISSION

RELATED APPLICATION

This application is a continuation of prior U.S. patent application Ser. No. 16/384,753 filed Apr. 15, 2019, which is a continuation of prior U.S. patent application Ser. No. 15/364,421, filed Nov. 30, 2016, issued as U.S. Pat. No. 10,277,651, which is a continuation of prior U.S. patent application Ser. No. 13/811,334, filed Mar. 20, 2013, issued as U.S. Pat. No. 9,531,579, which is a national stage entry under 35 U.S.C. § 371 of International Application No. PCT/EP2010/004879, filed Aug. 10, 2010, the entire disclosure of each being hereby incorporated by reference herein.

TECHNICAL FIELD

The present invention relates to a method for controlling the transmission of a media stream. Devices and software programs embodying the invention are also described.

BACKGROUND

An important application of transmission networks like the Internet or mobile telephone networks is the media delivery from a server to a client. Media may be for example audio and video.

Media delivery in IP (Internet Protocol) based networks may use different transport protocols. Traditionally, either RTP (Real-time Transport Protocol) over UDP (User Datagram Protocol) is used for real-time streaming and packet-based streaming or HTTP (Hyper Text Transfer Protocol) over TCP (Transmission Control Protocol) for download of whole files, mostly for later consumption but also for life streaming. RTP allows for dynamic adaptation to available bit-rate as measured by the client. A drawback of RTP and the associated control protocol RTSP (Real-time Streaming Protocol) is the need for specialized and more complicated server software, while HTTP can use widely deployed and inexpensive HTTP server software. A recent development, Adaptive HTTP Streaming (AHS), aims at combining the advantages of both approaches. AHS is standardized in 3GPP (Third Generation Partnership Project), and also adopted and slightly extended in the Open IPTV Forum (OIPF). MPEG (Moving Pictures Experts Group) is also working on AHS.

In AHS, the content is encoded in different versions, usually corresponding to different bit rates. If the content is for example a video with a video track and an audio track, the video track could be encoded in three versions with different bit rate each, and the audio track in a high-quality stereo and a mono version. Each version is further divided into segments of a few seconds duration. For example, the video versions can be divided into many consecutive segments of 10 seconds duration each. The segments may be formatted according to the MPEG-4 file format, or according to the MPEG-2 transport stream format.

The actual transmission of the video and audio tracks is performed by downloading one segment after the other initiated by the client. In this procedure the client downloads a segment using a standard HTTP request, unpacks, decodes, and renders it, and then does the same for the next segment etc. The client has knowledge about the available quality versions, and about the segment separation over time by means of a media description, the so-called Media Presentation Description (MPD). The MPD format as defined in

3GPP and OIPF is an XML (eXtensible Markup Language) encoded file containing appropriate information and attributes to describe the media. The MPD is the first resource transmitted to a client in order to start an AHS based media delivery. The MPD as it is specified by 3GPP comprises the different available qualities and information how they are arranged into segments.

Each segment is downloaded at the maximum available speed under the present operation conditions of the network used for transmission and the client monitors the download speed it experiences. Based on the experienced download speed the client selects the most appropriate of the available quality versions. From segment to segment this may be a different version, and the client can download different qualities depending on the present operation conditions, hence the attribute “adaptive” HTTP streaming. FIG. 1 visualizes the principle and shows different media representations for adaptive HTTP streaming of a content item as a function of the playout time. The three representations in FIG. 1 may correspond to a high, medium and low bitrate representation, respectively, of a content item, i.e. stream. Begin and end of the playout time for the stream segments of different representations coincide so that smooth switching between the representations is possible. The vertical scale in FIG. 1 illustrates the data size of the different stream representations, e.g. their bit rate. Depending on the client implementation, enhanced selection procedures are possible for switching between the representations, e.g. including a hysteresis in order to avoid excessive quality fluctuations when viewing or listening to a stream.

Another trend in multimedia communication is the usage of the IP Multimedia Subsystem (IMS) for the initiation and control of multimedia sessions. Within 3GPP, standardized solutions for IMS controlled RTP streaming as well as for IMS controlled HTTP progressive download are defined in 3GPP TS 26.237 V9.3.0 (2010-06) with the title IP Multimedia Subsystem (IMS) based Packet Switch Streaming (PSS) and Multimedia Broadcast/Multicast Service (MBMS) User Service; Protocols. These solutions benefit from the standardized features offered by IMS like charging, authentication or QoS (Quality of Service) reservation.

FIG. 2 shows the different signaling steps in case of IMS controlled HTTP progressive download as defined in 3GPP TS 26.237. The session is initiated with a SIP (Session Initiation Protocol) INVITE message which includes SDP (Session Description Protocol) information. The HTTP URL (Uniform Resource Locator) for download is delivered to the user equipment (UE), i.e. client, via the SIP 200 OK message. In addition, a QoS reservation for the HTTP progressive download session may be carried out. The progressive download itself is initiated by the UE with a HTTP GET command towards the HTTP server, which in return responds with the requested content file. In more detail, the following steps are performed:

1. The UE initiates the progressive download session by sending SIP INVITE to the IM CN subsystem, including an SDP offer.
2. The IM CN subsystem forwards the SIP INVITE message to the SCF.
3. The SCF verifies the user rights for the requested content, selects an HTTP/SIP adapter, and forwards the SIP INVITE message to the HTTP/SIP adapter.
4. The HTTP/SIP adapter selects an HTTP Server, and sends an HTTP POST message to the HTTP server, including the IP address of the UE.
5. The HTTP server answers to the HTTP/SIP adapter with a HTTP 200 OK response.

6. The HTTP/SIP adapter sends the SIP 200 OK answer to the SCF, including download URL of the requested content file in the SDP answer.
7. The SCF forwards the SIP 200 OK to the IM CN subsystem.
8. The IM CN subsystem forwards the SIP 200 OK to the UE.
9. The UE sends an HTTP request to the URL obtained from the SIP 200 OK message.
10. The HTTP server delivers the content file in the HTTP response to the UE.

The current AHS concept as specified e.g. in 3GPP TS 26.234 Transparent end-to-end Packet-switched Streaming Service (PSS), Open IPTV Forum—Release 2 Specification, HTTP Adaptive Streaming, DRAFT V0.06-Jun. 7, 2010 or in proprietary solutions like Microsoft Smooth streaming or Apple streaming (see R. Pantos, HTTP Live Streaming, <http://tools.ietf.org/html/draft-pantos-http-live-streaming-01>) specify only the media packaging, media description and download mechanisms. No connection is foreseen to combine the mechanism with resource or QoS reservation mechanisms. Thus, even in managed systems where QoS reservation and control is possible, AHS works with best effort and will in general therefore still require adaptation.

SUMMARY

It is an object of the present invention to provide an improved method for controlling the transmission of a media stream and corresponding devices.

The proposed method relates to a media stream comprising a plurality of consecutive stream elements. In the method, a media description of the media stream is obtained. The media description indicates an initial element of the stream elements. A request for the initial stream element is sent. A session control procedure for a session is also initiated. In the session control procedure, the media stream is associated with the session. The transmission of a subsequent element of the stream elements is controlled in accordance with a control rule of the session.

A method for controlling the transmission of a media stream comprising a plurality of consecutive stream elements can also be performed in a media client. The method in the client comprises the step of obtaining a media description of the media stream. The media description indicates an initial element of the stream elements. The media client sends a request for the initial stream element. The media client initiates also a session control procedure for the transmission of the media stream.

A media client according to the invention comprises a controller coupled to a sender and a receiver. The controller is adapted for controlling the transmission of a media stream to the receiver. The media stream comprises a plurality of consecutive stream elements. The controller is further adapted to obtain a media description of the media stream. The media description indicates an initial element of the stream elements. The controller is also adapted to initiate sending of a request for the initial stream element by the sender and to initiate a session control procedure for the transmission of the media stream.

An advantageous media server has a controller for controlling the transmission of a media stream comprising a plurality of consecutive stream elements in response to requests for the stream elements from a client. The media server comprises also a sender adapted to send the stream elements. The media server comprises furthermore a receiver for receiving a request for an initial element of the

stream elements, the request indicating the initial element. The receiver is also adapted to receive a result of a session control procedure for the transmission of the media stream, and to receive a further request for a subsequent element of the stream elements. The controller is coupled to the sender and to the receiver and adapted to control the sending of the subsequent element based on the result of the session control procedure.

A method in a media server controls the transmission of a media stream comprising a plurality of consecutive stream elements in response to requests for the stream elements from a client. The method comprises the step of receiving a request for an initial element of the stream elements. The request indicates the initial element. The indicated initial element is sent. In a further step a result is received of a session control procedure for the transmission of the media stream. Upon receiving a further request for a subsequent element of the stream elements the sending of the subsequent stream element is controlled based on the result of the session control procedure.

An advantageous control entity is suitable for performing a session control procedure with a media client for the transmission of a media stream comprising a plurality of consecutive stream elements from a media server. The control entity comprises a receiver for receiving signaling of a session control procedure for the transmission of the media stream. A controller is adapted for terminating the signaling and coupled to the receiver. The controller is also adapted to associate the media stream with the session in the session control procedure. The controller is coupled to a sender for an instruction initiating control of the transmission of a subsequent element of the stream elements in accordance with a control rule of the session.

A method in a control entity is performed for a session control procedure with a media client for the transmission of a media stream comprising a plurality of consecutive stream elements from a media server. The method comprises the step of receiving signaling of a session control procedure for the transmission of the media stream. The signaling is terminated and the media stream is associated with the session in the session control procedure. An instruction is sent for initiating control of the transmission of a subsequent element of the stream elements in accordance with a control rule of the session.

A media proxy is suitable for forwarding media descriptions from a server to a client. The media proxy comprises a receiver for receiving, from the server, a media description comprising a plurality of representation descriptions. Each representation description indicates a different representation of the media stream. A processor is adapted to modify the media description by removing or modifying at least one of the representation descriptions and a media source of the at least one representation description from the media description. A sender is adapted for sending the modified media description towards the client.

A method in a media proxy for forwarding a media description from a server to a client comprises the steps of receiving the media description from the server. The media description comprises a plurality of representation descriptions, each representation description indicating a different representation of the media stream. The media description is modified by removing or modifying at least one of the representation descriptions and a media source of the at least one representation description from the media description. The modified media description is sent towards the client.

The above methods may also be implemented as programs which can, for example, be stored on a data carrier or

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loadable into a processing system or memory of the devices described, e.g. as a sequence of signals.

The foregoing and other objects, features and advantages of the present invention will become more apparent in the following detailed description of embodiments as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates media representations of a media stream;

FIG. 2 shows a signaling diagram of an IMS controlled HTTP download;

FIG. 3 shows a flow chart of the proposed method;

FIG. 4 shows a media client adapted to the proposed method;

FIG. 5 shows a media server adapted to the proposed method;

FIG. 5a shows a method executed in a media server;

FIG. 6 shows a control entity adapted to the proposed method;

FIG. 6a shows a method executed in a control entity;

FIG. 7 shows a media proxy adapted to the proposed method;

FIG. 7a shows a method executed in a media proxy; and

FIG. 8 shows a signaling diagram for an embodiment of the proposed method.

DETAILED DESCRIPTION

The present method relates to controlling the transmission of a media stream comprising a plurality of consecutive stream elements. A first embodiment of the method is illustrated in FIG. 3. The stream elements may be for example stream segments as they are used e.g. in HTTP streaming. Segments may be available in different qualities, e.g. with different media resolution. The stream may relate for example to a video track or an audio transmission and different streams may be associated with each other, e.g. a video track with an audio track. The stream can be transmitted to a client which may be any user equipment adapted to render the stream to a user, for example a personal computer or a mobile phone.

In the method a media description of the media stream is obtained 32, e.g. from a file downloaded by the client. The media description indicates an initial element of the stream elements, e.g. as a media source like a URI from which the initial element is available. In general, media sources may also be indicated by a template for generating URIs to elements by the client in order to avoid that the source for each element of a stream needs to be individually transmitted, e.g. by providing a rule to generate the source of the n^{th} element of a stream as a function of n . In the terminology of the present text, the media source indicates the specific origin of a stream element, in contrast to the platform hosting (e.g. storing or generating) and providing the stream element, e.g. a server or a network. Accordingly, the request may be addressed, e.g. with an IP address and port number, to the platform and include the media source, e.g. in the form of an HTTP GET message included in the request.

The media file may also comprise one or more descriptions of different representations of the stream, e.g. an indication of different image resolutions of a video. Optionally, a plurality of media sources is indicated for the initial element, e.g. if the stream is available in different qualities or from different servers and the client can select one of them. A request for the initial stream element is sent 34, for

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example by the client, to the platform to obtain the initial element from the media source.

A session control procedure for the transmission of the media stream is also initiated 36, for example by the client or the network. A session is a transmission context between the client and a network performing the transmission with specified transmission properties which may for example be enforced by a policy control element of the network. In wireless networks a session is typically associated with a radio access bearer transporting the session. The session control procedure may be any procedure associating 38 the media stream with a session, e.g. a session establishment for the stream or a modification of an existing session in which the media stream is associated with the session. The association specifies the session in which the stream is transmitted.

The session control procedure may be initiated before, at the same time or after sending the request. In embodiments it is advantageous if the initiation of the session control procedure and the request are done essentially simultaneously or shortly after each other. Accordingly, the media streaming can be initiated before the session control procedure is finished.

The transmission of a subsequent element of the stream elements, i.e. a stream element sent after full or partial conclusion of the session control procedure can then be controlled 40 in accordance with a control rule of the session. The subsequent element is not necessarily immediately succeeding to the initial element and it is possible that one or more elements exist between both, e.g. depending on the time for execution of the session control procedure and the presentation time of the stream elements. Typically the control is performed for any subsequent stream element. The at least one control rule may define for example a particular quality of service for the session, e.g. a bit rate, the initiation of a billing procedure or the blocking of a session, e.g. if the user is lacking a corresponding subscription or account balance. The control may also comprise a monitoring or an integration of the stream handling with other services, e.g. a push service to provide background information to a stream or an ordering service, e.g. for allowing to buy the soundtrack of a streamed movie. The control according to the control rule may be performed by a policy enforcement point, e.g. at a gateway, transmitting the stream wherein the stream elements can be identified for example based on address information in the elements, e.g. in a packet header of the elements.

In an embodiment, the session control procedure comprises the step of obtaining a resource locator indicating a source for session control associated with the media stream. This allows sending a request to a corresponding platform for initiating the session control procedure with the source for session control. The resource locator may be included in the media description or associated with the media description, e.g. transmitted in the same message as the media description. In this case both are simultaneously available.

Optionally, the media description comprises or is associated with at least one information element specifying a session parameter in the session control procedure. For example the media description or individual representations in the media description may indicate a bandwidth required to transmit the stream or stream representation. The parameter can then be specified, e.g. in an SDP file, as requirement for establishing or modifying the session with which the stream is to be associated.

The session control procedure may comprise the step of receiving a session control response for the session control

procedure by a client, e.g. a SIP 200 OK message, in particular if the session control procedure is initiated by the client. The client may then send, upon reception of the session control response, a request for the subsequent element or elements of the stream, generally indicating a further media source. For example, after association of the stream with the session a higher stream quality may be requested, which is available from the further source. If the request for the subsequent element indicates a further media source this may also simplify identification of the stream elements for the purpose of policy control. A further media source may be hosted on the same or a different platform, e.g. server, as the initial source for the stream elements.

If the session control procedure comprises the step of receiving a session control response for the session control procedure by the client, the client may also send, upon reception of the session control response, the request for the initial element of the stream, i.e. the order of the steps differs from the embodiments discussed so far. In this case, the start of the streaming session may be delayed compared to other embodiments described but it can be ensured that an appropriate session exists from the beginning of the stream. This can avoid access to initial elements of a content which shall not be received without prior authorization. Accordingly, the steps of sending the request for the initial stream element is delayed in this embodiment until reception of the session control response and the step of controlling the transmission may not only relate to the subsequent elements but may also include the transmission of the initial element. In this case it is possible that the media description is only obtained by the client with the session control response for the session control procedure, e.g. a SIP 200 OK message, and the response may also comprise further information as discussed below. It is merely required that information identifying the media stream can be obtained in the session control procedure, e.g. provided by the client.

The session control response may indicate one or more parameters specifying the session. This may be for example a session identifier to allow handling or monitoring of the session. A parameter specifying the session may indicate also a granted quality of service if the session control procedure comprises a resource reservation. If a further media source for subsequent stream elements is selected from a plurality of media sources for the subsequent element, each media source from the plurality may be associated with a different parameter specifying the session. This allows for example a selection of different stream qualities or platforms for download based on the parameter in the control response.

The session control response may also comprise an indication of a media source, e.g. as a URI of the media source or as a template to generate a plurality of URIs. In this way, the control response may indicate e.g. a source for a media representation which was indicated in the media description without an associated source, for example if the use of the respective source is not authorized without prior session control procedure, e.g. to initiate a billing.

The session control response may also include a media description comprising, e.g., further representations of the media stream. If the included media description is updated from a version received earlier it is possible that the reception of the updated media description triggers a further session control procedure, like e.g. a QoS renegotiation in order to modify the session parameters to obtain the required session parameters for a high quality video, for example

after a prior session control procedure allowed the access to the stream in general based on an initiated billing or check of the client subscription.

The parameter specifying the session may also be included into the request for the subsequent element. This allows for example a session identification to authenticate that the client is allowed to access the media from a further media source or to associate the session with messages from control entities for the session.

Both the further media source and the source for session control may be specific for the session, i.e. they may be associated with the session. For example the further media source may be generated in response to the session initiation and may comprise an arbitrary or pseudo arbitrary element so that it can not easily be guessed and provide access only for the session. Also an individual source for session control may be sent in a personalized message or media description. This can avoid unauthorized access and denial of service attacks. It is also possible that initial media sources are specific for the media description or, depending on the embodiment, the session.

In a further embodiment, the media description comprises a plurality of representation descriptions, each representation description indicating a different representation of the media stream and an associated media source. Both an initial and a further media source can then be selected based on the media description, e.g. to obtain different quality levels of a media stream. The selected media source can then be included into the request for the initial element or into the request for the subsequent element.

A client, e.g. a UE, may be adapted to perform a method for controlling the transmission of a media stream comprising a plurality of consecutive stream elements. According to the method the client obtains a media description of the media stream, for example by receiving it in a message in response to a request or in any other way. The media description indicates an initial element of the stream elements, e.g. as a media source like a URI from which the initial element may be requested. Accordingly the client sends a request for the initial stream element from the media source, e.g. to an associated platform. The client also initiates a session control procedure for the transmission of the media stream. The initial stream element can be requested without waiting for conclusion of the session control procedure, e.g. a session establishment or modification for a session to which the media stream can be associated. Correspondingly, an initial transmission, e.g. with best effort quality, can be quickly performed while waiting for the session establishment which can offer additional options of stream control and handling, e.g. a defined QoS. This can particularly enhance user experience when beginning the stream playout.

A media client **48** adapted to perform aspects of the above methods is shown in FIG. 4. It comprises a controller **50** coupled to a sender **52** and a receiver **54**.

Sender **52** and receiver **54** may be adapted to send and receive radio transmissions in a fixed or wireless communication system, e.g. as parts of a transceiver. Transmissions can be sent, e.g., as IP packets comprising HTTP requests and responses. The controller **50** may be implemented for example in a processing system **56** with a memory **58** which execute control routines implemented, e.g., by software programs.

The controller **50** is adapted for controlling the transmission of a media stream comprising a plurality of consecutive stream elements **60**, and to obtain a media description **62** of the media stream. The transmission control can be per-

formed by control messages initiated by the receiver, in particular by requests **66** for stream elements from media sources. The media description indicates an initial element **64** of the stream elements, e.g. as a media source. The controller **50** is further adapted to initiate sending of a request **66** for the initial stream element by the sender **52**, e.g. to a platform hosting the media source, and to initiate a session control procedure for the transmission of the media stream.

The depicted media client comprises also hardware like a screen **70** or a loudspeaker **72** to render the received stream to a user. For this purpose the client comprises a playout logic **74** which may also be implemented in the processing system **56**. The playout logic **74** receives the stream elements **60** from the receiver **54** and unpacks and decodes them for playout by the screen **70** or the loudspeaker **72**. The controller **50** may also be adapted to request one or more further stream elements **60** when they are needed for playout, to select a representation of the media stream based on information in the media description **62** and a monitored data rate of received stream elements and to initiate requests **66** by the sender **52** for the respective representation. The monitoring of the data rate can be performed for example by detecting the sizes of stream elements and measuring the time for their transmission. In case of AHS, specific requests **66** correspond to specific stream elements **60** as indicated by the element labels in the figure.

A media server **80** adapted to perform aspects of the above methods is shown in FIG. **5**. It comprises a controller **82** for controlling the transmission of a media stream comprising a plurality of consecutive stream elements **84** in response to requests **86** for the stream elements from a client, e.g. the client as described with respect to FIG. **4**. The media server **80** comprises a sender **88** for sending the stream elements **84** towards the client and a receiver **90**. Sender and receiver may be adapted for radio or wire line transmission. Receiver **90** is adapted to receive a request **86** for an initial element **92** of the stream elements, which request **86** indicates the initial element **92**, e.g. as a media source like a URI. The receiver **90** is also adapted to receive a result of a session control procedure for the transmission of the media stream, for example from a control entity of a network transmitting the media stream and to forward it to controller **82**.

Receiver **90** is still further adapted to receive a further request for a subsequent stream element **94** of the stream elements. The further request may comprise a further media source of the subsequent element. In case of AHS, specific requests **86** correspond to specific stream elements **84** as indicated by the element labels in the figure.

The controller **82** is coupled to the sender **88** and to the receiver **90** and is adapted to control the sending of the subsequent stream element **94** based on the result of a successful session control procedure. For example the sending may be performed if a confirmation of the session control procedure is received and the sending may be blocked if no confirmation is obtained. It is also possible that the controller **82** allows or blocks access to specific representations of a stream element, e.g. to a segment of a high-resolution video, based on the result or returns a different, e.g. a lower-quality representation than requested. A plurality of further options is conceivable.

Media server **80** typically comprises also a stream generator **96** which encodes the stream elements **84** for transmission, e.g. based on information stored in a memory **98** or based on received information, e.g. via a further receiver **106** or from higher protocol layers. It is possible that the media

server is itself a user equipment, e.g. when streaming content recorded by a mobile phone camera or microphone.

In an embodiment of the media server **80**, the sender **88** is adapted to send a media description **100** of the media stream to the client. Transmission of the media description **100** can also be initiated by a request from the client which is not shown in the figure. The media description **100** indicates a media source for the initial element **92** of the stream elements and optionally also a further media source of the subsequent stream element **94**.

In this embodiment, a processor **102** may be adapted to obtain an initial media description, e.g. from memory **98**, comprising a plurality of representation descriptions, each representation description indicating a different representation of the media stream, and optionally indications of associated media sources. Processor **102** may be further adapted to remove at least one of the representation descriptions from the initial media description in order to specify the media description **100** for transmission. The processor may also modify the representation description, e.g. to values which avoid selection by the client. If a source indication exists it can also be removed or modified, e.g. to replace a high quality source by a low quality source. Optionally, the processor may merely remove a media source while keeping the representation description so that the receiver is informed about the existence of the representation without getting the associated source. Similarly, instead of merely removing a representation description with associated source, a tag may be included instead of the removed representations, which indicates to the client that at least one further representation is available. In this way the server can generate a modified media description which may be used prior to the session control procedure. The processor **102** may be part of a processing system **104**.

FIG. **5a** depicts a corresponding method in a media server controlling the transmission of a media stream comprising a plurality of consecutive stream elements in response to requests for the stream elements from a client. The method starts with the steps of receiving **110** a request for an initial element of the stream elements. The request indicates the initial element, e.g. as a media source identifying the stream element. In response to the request, the initial element is sent **112** towards the client. At any point in time during the method a result of a session control procedure for the transmission of the media stream is received **114** by the media server. When the media server receives **116** a further request for a subsequent element of the stream elements, it can control **118** the sending of the subsequent element based on the result of the session control procedure.

FIG. **6** shows a control entity **200** for controlling a session with a media client for the transmission of a media stream comprising a plurality of consecutive stream elements from a media server, e.g. a server as described above. The control entity may for example be implemented as an HTTP/SIP adapter. Control entity **200** comprises a receiver **202** for receiving signaling messages **204** of a session control procedure for the transmission of the media stream, for example SIP messages. The messages are e.g. initiated by a media client as described above and forwarded by further network elements which may also obtain session related information from the session control procedure and are thus capable to execute or initiate control operations related to the session.

A controller **206** terminates the signaling, i.e. it is an endpoint for the signaling. Accordingly, it processes the signaling messages **204** and may initiate the sending of responses **208** by a sender **210**. For this purpose, the controller **206** is coupled to the receiver **202** and sender **210**.

Controller **206** is furthermore adapted to associate the media stream with the session in the session control procedure. For example, the controller **206** may select an existing session for transmitting the media stream and possibly modify session parameters for this purpose or the controller may establish a new session for the media stream. A memory **212** allows storing and retrieving information for the session. The controller may be implemented in a processing system **214** of the control entity **200**.

Based on the result of the session control procedure, controller **206** initiates the sending of an instruction **216** by a sender **218**. The instruction **216** initiates control of the transmission of a subsequent element of the stream elements in accordance with a control rule of the session and can be sent to a media server transmitting the media stream or to a policy enforcement point of the session. A receiver **220** corresponding to sender **218** allows receiving e.g. a confirmation **222** for the instruction **216**. The control entity may also obtain information via receiver **220** which may be sent to the client or used in defining session parameters, e.g. a media description or media sources. Sender **218** and receiver **220** may be identical to sender **210** and receiver **202** or may be different entities and they may also use a different protocol, e.g. HTTP, possibly depending on the recipients. Sender **218** and receiver **220** may also correspond to an internal interface of a device if the instruction is sent to an entity implemented on the same platform.

A method in a control entity for performing a session control procedure with a media client for the transmission of a media stream comprising a plurality of consecutive stream elements from a media server starts with the step of receiving **240** signaling of a session control procedure for the transmission of the media stream. The control entity terminates **242** the signaling and associates the media stream with the session in the session control procedure. Based upon the session control procedure, the control entity sends **244** an instruction initiating or modifying transmission control of one or more subsequent elements of the stream elements in accordance with a control rule of the session.

A media proxy **250** for forwarding media descriptions from a server to a client is depicted in FIG. 7. Generally, the media proxy will forward also a plurality of other messages, requests and responses between the client and the server, e.g. the stream elements and requests for stream elements. The media proxy **250** comprises a receiver **252** for receiving, from the server, a media description **254** comprising a plurality of representation descriptions. Each representation description indicates a different representation of the media stream. In the example, the media description **254** comprises three descriptions of representations **R1-R3** of the media stream with an associated source **S1-S3** for each representation. It is also possible that the media description comprises descriptions of representations without a media source as indicated for representation description **R4**. In this case a client is informed about the existence of the representation but needs to perform further steps, e.g. association of the media stream with a session, before obtaining the source.

A processor **256** which may be part of a processing system **258** is adapted to modify the media description by removing or modifying at least one of the representation descriptions and/or an associated source from the media description **254**. In the example, the description of representation **R2** is removed together with the associated source **S2**, e.g. if a radio network to which the client is attached does not support the required data rate. For representation **R3** only the source **S3** is removed, e.g. if prior session setup is required for the media stream to ensure the necessary quality of

service or if a billing shall be performed for the representation. The representation **R1** with source **S1** remains in the media description so that an initial source is available for the client, e.g. to allow initiating the playout using a best effort bearer. A memory **260** allows storing and retrieving data required for modifying the media description.

A sender **262** sends the modified media description **264** towards the client. Generally, a corresponding receiver **266** exists also for sender **262** and a sender **268** for receiver **252** to allow corresponding transmissions in the return direction. It is possible that the functions of both senders are performed by the same physical device; the same applies to both receivers.

The processing for modifying a media description as described for processor **256** can also be performed in other entities, e.g. in a media server.

A method in a media proxy for forwarding a media description from a server to a client comprises the step of receiving **280** the media description. The media description is received from the server and comprises a plurality of representation descriptions, each representation description indicating a different representation of the media stream. The media proxy modifies **282** the media description by removing or modifying at least one of the representation descriptions and a media source of the at least one representation description from the media description. Finally, the modified media description is sent **284** towards the client.

Any entity of the group comprising the media client, the media server, the control entity and the media proxy as well as the respective methods executed in the individual entities may be used in any embodiments of the method described and be accordingly adapted, i.e. implement those aspects of the method embodiments relating to the respective entity.

The proposed method can be used for example in IMS based QoS reservation for adaptive HTTP streaming. It specifies in this case a concept for integration of Adaptive HTTP streaming with SIP based control signaling with an IMS controlled infrastructure and allows and enables IMS specific features like QoS, billing, authentication etc. for Adaptive HTTP streaming. The proposed integration allows AHS backwards-compatibility to non-IMS capable devices, fast service startup, and service differentiation. The integration is based on the idea to include IMS control information, e.g., SIP URI (Uniform Resource Identifier), into the MPD.

In the following a more detailed technical description of embodiments employing some of the above general concepts is made in the terms of IMS controlled AHS. It is assumed that the client has obtained the URL of the Media Presentation Description (MPD) file by any means, e.g., as link in an HTML page or in a message. FIG. 8 depicts the sequential interworking of affected entities, e.g. nodes.

Entities that are involved in the message flow are a User Equipment (UE), e.g., a mobile phone, as an example of a media client and an IP Multimedia Core Network Subsystem (IM CN Subsystem) which may be for example a core network of a mobile telephone system with a radio access network for allowing mobility of the UE. A Session Control Function (SCF) provides service logic and functions required to support execution of such logic, which may include for example service authorization during session initiation and session modification, checking user's service subscription in order to allow or deny access to a service or selections of media functions. The rules of such functions and their activation are subject to operator implementation. An HTTP/SIP adapter as an example of a control entity terminates the SIP signaling and communicates with an

HTTP server which performs, as an example of a media server, the streaming of the media.

In many embodiments of the described procedures the IM CN Subsystem and the SCF can be standard IMS components and are then only affected by implementing rules and elements for controlling the media transmission. More than a single HTTP server may be used in the media streaming, e.g., when the MPD and the different media qualities are distributed via different servers. Furthermore, a Content Distribution Network (CDN) may be used instead of HTTP servers. The HTTP/SIP adapter and the HTTP server may be implemented as components on the same hardware or even within a single software. In this case, the interface between the two components may be different from the example shown in FIG. 8, i.e., not based on HTTP. The interface may instead, e.g., be based on API (Application Programming Interface) calls.

In the signal flow of FIG. 8, the UE performs an HTTP request **10a** to the MPD URL, i.e., to the HTTP server that provides the MPD. The HTTP server responds with an MPD that contains the representation descriptions for all quality levels or, as an embodiment, only for the quality levels that are considered suitable for best effort transmission in the network. The returned MPD in the HTTP response **10b** is accompanied by a SIP URI which enables SIP capable terminals to request a session setup for an AHS session. The SIP URI could be included for example as a standardized new MPD attribute, it may be packaged inside an existing MPD element or it could be part of the response **10b** to the HTTP request, e.g. as part of a multipart response comprising a plurality of HTTP or other elements.

For these steps several options exist:

The request **10a** may be proxied by an Application Layer Gateway (ALG) which may be located in the network, for example in the IM CN subsystem. The ALG is an example of a media proxy and may scan the requests for MPD files, remove representations and add a SIP URI to request QoS for the session.

Instead of including the SIP URI in the MPD, it may be included as a separate element and be transported in a multipart message of response **10b**.

The response **10b** including the MPD may also include additional information that the UE can utilize to generate an SDP file for the subsequent SIP INVITE message **1**. This may, e.g., be additional information on the media which can be used to construct the SDP media part or an SDP template that the UE may use after completion of the variable parts of the template. In this way, the UE can either use stored information and routines to construct the SDP media part or receive the template for the request which comprises specific information elements which should be filled in like ports or media formats.

Instead of including the SIP URI in the MPD another type of URI (e.g. an HTTP URL) may be included which can be resolved to a SIP URI, e.g., by means of redirection.

In step **10c** both IMS capable and non-IMS capable UEs initiate the AHS session. This allows a quick stream startup time and can be done using a best effort connection, e.g. on a default bearer to the IM CN Subsystem. In this way, also backward compatibility is possible wherein a non-IMS capable UE can ignore the SIP URI provided.

Devices that are IMS capable can in parallel to the AHS session startup send a SIP INVITE message **11-13** to the SIP/HTTP adapter. The INVITE is addressed to the previously communicated SIP URI. The INVITE message includes either no SDP, an SDP file generated by the client

or the filled out SDP template that the client might have received with the MPD answer in response **10b**.

If the SIP/HTTP adapter and the HTTP server are two separate entities, the SIP/HTTP adapter issues an HTTP request **14**, e.g., a POST or GET request, to the HTTP server to obtain the URL to an original MPD and/or the original MPD itself which is returned in response **15**. The term "original" indicates that this MPD can comprise an unfiltered list of the media representation descriptions available at the server while the MPD included in response **10b** may have some of the representations removed. Due to the information in the original MPD, the SIP/HTTP adapter is able to issue a SIP 200 OK message **16** including an SDP that contains the information about the already ongoing AHS session of step **10c**. The SIP 200 OK message is forwarded to the UE in steps **17** and **18**. For example, in case the UE, i.e. client, shall get access to different media qualities, the SIP 200 OK message may contain an updated MPD URI which may comprise one or more additional media representations compared to the MPD included in response **10b**. The updated MPD may either be the original MPD or a version edited, e.g. by the SIP/HTTP adapter or a proxy.

During the transmission of the data, the IM CN initiates enforcement of the specified policy, e.g. a QoS, for the media session, optionally including a bearer update. QoS reservation and policy enforcement may use the standard 3GPP mechanisms defined in 3GPP TS 23.203 titled Policy and charging control architecture. For example using the information from the MPD and the client IP address, ports, etc., corresponding Policy and Charging Control (PCC) rules may be created. The PCC rules allow policy enforcement points, such as gateways, to identify and prioritize packets belonging the HTTP streaming session. Packets exceeding bandwidth agreements may be marked to indicate congestion or may be dropped. PCC rules which consider other elements than IP addresses or ports, e.g. by relating to a service which may be identified by deep packet inspection at the policy enforcement points, allow also the usage of the described mechanism in case the HTTP Server is replaced by a cache or a CDN where the content can be streamed from multiple locations.

As a result of the policy enforcement and QoS provision for the media streaming session, the streaming client observes operation conditions of the network, e.g. an observed download speed, which is specific for the session. Accordingly, the client may adapt to the transmission conditions provided by the network using the existing AHS mechanisms of transmission monitoring without need for a corresponding signaling.

After the UE has received message **200 OK 18** and is aware of the established QoS, it may optionally check the HTTP server for an update of the MPD with HTTP request **19a** and response **19b**. The HTTP server may provide the update based on the information received in message **14** or by another confirmation of association of the media stream with the session. In case that response **10b** did not include high quality media representations, the UE receives now an updated MPD with all representations according to the available QoS.

In step **20** the UE can adapt the requested media quality according to any newly available representations, e.g. higher quality levels, based on the adaptation algorithms in AHS. In this way the network operator may provide both service differentiation for different users and the required QoS for a specific media quality.

For non IMS capable devices step **20** is immediately executed after step **10c** without update of the media quality.

Further optional functionality and embodiments of the procedures are possible:

In response **10b** an indication of more available quality levels may be given, e.g., through a specific tag or through the presence of more representations, including the bandwidth attribute, but without including <InitialisationSegmentURL> or <sourceURL> elements, i.e. media sources like links to media.

An SDP offer for the session can be generated by the UE or by the SIP/HTTP adapter. The required information is provided through the communication path and the MPD, e.g. sender and receiver IP address, media transport format and ports, and required bandwidth.

The removal of better quality representations from the MPD, e.g. by a server or proxy, in message **10b** is optional. If no representations are removed, the proposed procedure allows service quality reservation. In the other case it allows service differentiation, e.g. for a client with an identification of a user that booked a certain package or that can obtain it via IMS provided billing.

The URIs that are provided in the MPD may be generated in a specific way, e.g. personalized for the user, that makes it difficult to guess the URIs for higher quality layers so that they can not easily be accessed without the information in the MPD.

In some cases a simple filter in the policy enforcement point based on IP-5-tuples, i.e. a filter allowing or restricting packets based on at least one element from a group comprising source address, source port, destination address, destination port and protocol identification, is not suitable for QoS enforcement, e.g., for streaming of content from a CDN. In such cases, the PCC rules may contain other information. For example, HTTP specific information such as headers may be included, that can be used during deep packet inspection in QoS enforcement points to identify packets from the HTTP streaming session.

The HTTP server may only grant access to a certain media quality, i.e., stream segments of a particular representation, after receiving an indication of the successful SIP INVITE procedure. There may be an additional communication between the HTTP server, the SIP/HTTP adapter and/or the IM CN to check this. For example, the SIP/HTTP adapter or the HTTP server might register the IP address of the UE during the SIP INVITE and check upon an HTTP GET request as in step **10 a 19a** if the source IP of the GET request belongs to a registered UE.

Advantages depending on the particular embodiments may include the ability to benefit from the availability of resource reservation mechanisms and connect QoS reservation and control and AHS. Converged solutions can support both IMS and non IMS clients. Advantages of embodiments may also include

Fast startup of streaming, even in case of delays for IMS QoS establishment

Backwards-compatibility to existing and standardized AHS mechanisms

Enablement of service differentiation by making better quality available when QoS via IMS is used

Puts operator in control to decide, which quality levels should be available for best effort usage. This allows dynamic control of the network usage due to present conditions.

The above embodiments admirably achieve the objects of the invention. However, it will be appreciated that departures can be made by those skilled in the art without departing from the scope of the invention which is limited only by the claims.

What is claimed is:

1. A method, performed by a user equipment, the method comprising:

starting to receive a stream of media content from a server by fetching at least one media segment of the media content;

sending, after the stream of media content has started, an invitation to establish a control session for adapting the stream of media content according to a Quality of Service (QoS) reservation;

after receiving a response message accepting the invitation, receiving one or more further media segments of the media content in accordance with the QoS reservation.

2. The method of claim **1**, further comprising obtaining a description of the media content, wherein fetching the at least one media segment comprises fetching the at least one media segment based on information comprised in the description.

3. The method of claim **2**, wherein obtaining the description comprises obtaining the description in a Media Presentation Description (MPD) file.

4. The method of claim **1**, wherein starting to receive the stream comprises receiving the stream on a default bearer providing best effort service.

5. The method of claim **1**, further comprising participating in a bearer update procedure to enforce the QoS reservation.

6. The method of claim **5**, wherein receiving the one or more further media segments in accordance with the QoS reservation comprises receiving the one or media segments over a bearer updated by the bearer update procedure.

7. A user equipment comprising:

radio circuitry configured to exchange data over a radio communication channel; and

processing circuitry operatively coupled to the radio circuitry, wherein the processing circuitry is configured to:

start to receive a stream of media content from a server by fetching at least one media segment of the media content;

send, after the stream of media content has started, an invitation to establish a control session for adapting the stream of media content according to a Quality of Service (QoS) reservation;

after receiving a response message accepting the invitation, receive one or more further media segments of the media content in accordance with the QoS reservation.

8. The user equipment of claim **7**, wherein the processing circuitry:

is further configured to obtain a description of the media content;

is configured to fetch the at least one media segment based on information comprised in the description.

9. The user equipment of claim **8**, wherein to obtain the description, the processing circuitry is configured to obtain the description in a Media Presentation Description (MPD) file.

10. The user equipment of claim **7**, wherein to start to receive the stream, the processing circuitry is configured to receive the stream on a default bearer providing best effort service.

11. The user equipment of claim **7**, wherein the processing circuitry is further configured to participate in a bearer update procedure to enforce the QoS reservation.

12. The user equipment of claim **11**, wherein to receive the one or more further media segments in accordance with

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the QoS reservation, the processing circuitry is configured to receive the one or media segments over a bearer updated by the bearer update procedure.

13. A method, performed by a core network node in a communication network, the method comprising:

receiving, from the user equipment, an invitation to establish a control session for adapting a stream of media content in accordance with a Quality of Service (QoS) reservation, wherein the stream of media content has already been established between the user equipment and a server;

after receiving the invitation, initiating the QoS reservation for the stream of media content;

sending, to the user equipment and after initiating the QoS reservation, a response message accepting the invitation.

14. The method of claim **13**, further comprising forwarding the invitation to a Session Control Function (SCF) of the communication network, and receiving the response message accepting the invitation from the SCF.

15. The method of claim **13**, wherein the stream of media content was established before receiving the invitation and on a default bearer providing best effort service.

16. The method of claim **13**, wherein initiating the QoS reservation for the stream of media content comprises participating in a bearer update procedure to update a bearer and enforce the QoS reservation.

17. A core network node in a communication network, the core network node comprising:

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communication circuitry configured to exchange information using the communication network;

processing circuitry communicatively coupled to the communication circuitry and configured to:

receive, from the user equipment, an invitation to establish a control session for adapting a stream of media content in accordance with a Quality of Service (QoS) reservation, wherein the stream of media content has already been established between the user equipment and a server;

after receiving the invitation, initiate the QoS reservation for the stream of media content;

send, to the user equipment and after initiating the QoS reservation, a response message accepting the invitation.

18. The core network node of claim **17**, wherein the processing circuitry is further configured to forward the invitation to a Session Control Function (SCF) of the communication network, and receive the response message accepting the invitation from the SCF.

19. The core network node of claim **17**, wherein the stream of media content was established before receiving the invitation and on a default bearer providing best effort service.

20. The core network node of claim **17**, wherein to initiate the QoS reservation for the stream of media content, the processing circuitry is configured to participate in a bearer update procedure to update a bearer and enforce the QoS reservation.

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INVENTOR(S) : Willig et al.

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It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page

Page 2, item [56], in Column 2, Line 9, delete “Streaming (PSS)” and insert -- Streaming Service (PSS) --, therefor.

Page 2, item [56], in Column 2, Line 37, delete “Streaming (PSS)” and insert -- Streaming Service (PSS) --, therefor.

In the Specification

Column 1, Line 7, delete “2019,” and insert -- 2019, now Pat. No. 10,958,699, --, therefor.

Column 1, Lines 35-36, delete “life streaming.” and insert -- live streaming. --, therefor.

Column 1, Line 52, delete “bit rate” and insert -- bit rates --, therefor.

Column 5, Line 37, delete “media resolution.” and insert -- media resolutions. --, therefor.

Column 12, Line 50, delete “as” and insert -- a --, therefor.

Signed and Sealed this
Seventeenth Day of May, 2022
Katherine Kelly Vidal

Katherine Kelly Vidal
Director of the United States Patent and Trademark Office